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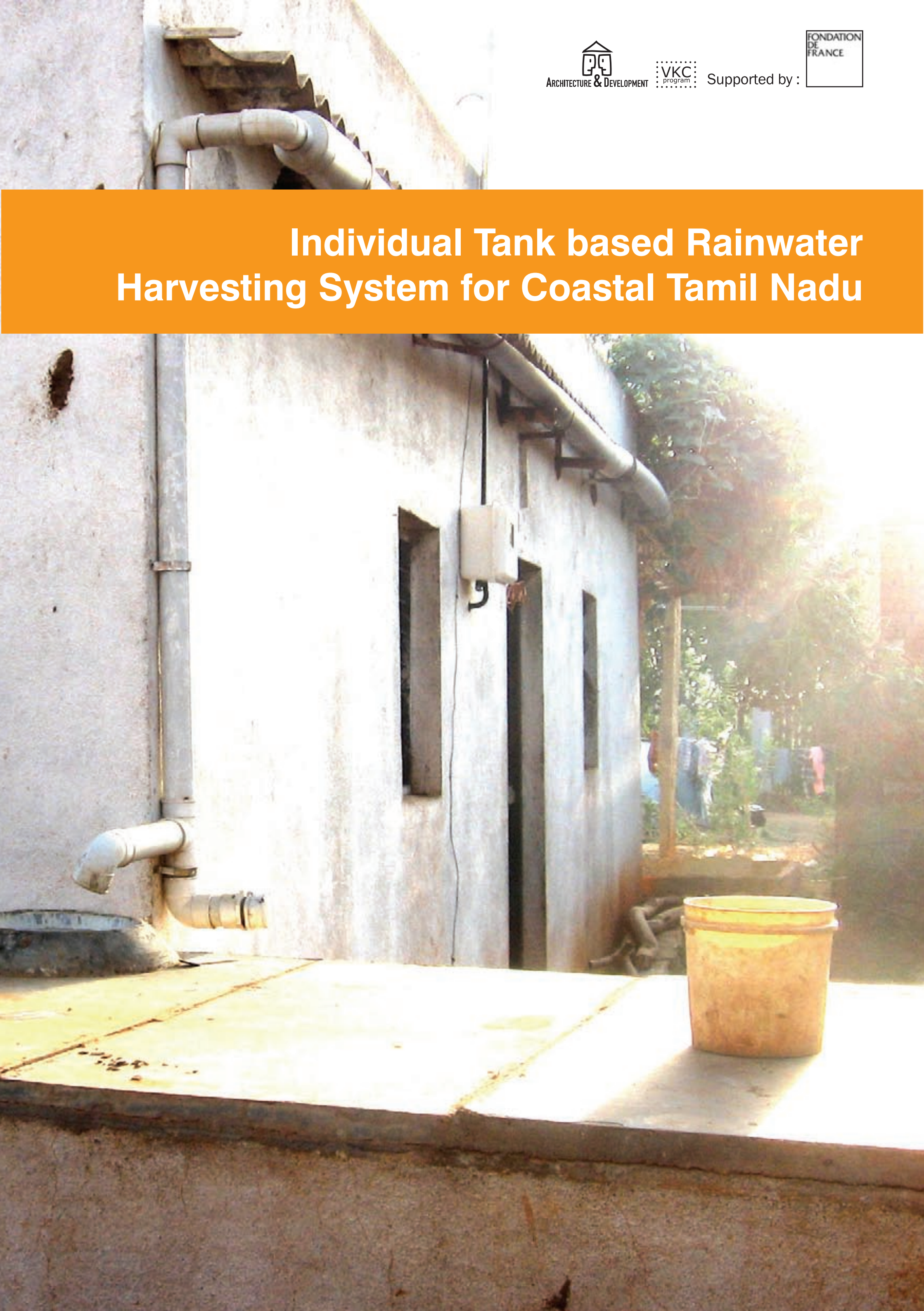
# Individual Tank based Rainwater Harvesting System for Coastal Tamil Nadu



# Individual Tank based Rainwater Harvesting System for Coastal Tamil Nadu

Architecture & Development

# Contents



# Introduction

The Coastal districts of Tamil Nadu are characterized by high population densities. These densities are amongst the highest in the country making for cramped settlements with very little open spaces. Another characteristic of this region is the severe water shortage which coupled with saline ingress into the area's aquifers has made life very difficult for the coastal people.
In the specific context of villages reconstructed after the Tsunami there is no magic solution. At the same time the inclusion of toilets and bathing areas within each house increases the demands of water. A toilet cannot be kept clean without water.
It was in this context that we started talking to people and looking at the rainfall data of the coastal districts of Tamil Nadu. We found that Individual Tank based Rainwater Harvesting systems presents a viable partial solution in tackling the water problems of this region.
This manual conceived keeping in mind flat roofed houses built as part of the Tsunami reconstruction effort. This has been done consciously. However the same principals can be applied elsewhere to get similar results.

Standard refrains about Rainwater harvesting from various people met during field work could be summarized as follows

1. It is a good idea but it does not work in reality
2. It is too expensive
3. It needs too much space, there is no space available
4. It is only recharging the ground water, people do not benefit directly

This simple manual hopes to demonstrate otherwise
Individual Tank based Rainwater Harvesting system:

1. It actually works and can address to a certain extent the water problem
2. It costs some money but is not expensive, it is low maintenance and has a long life
3. It needs very little space and actually works very well in cramped living conditions
4. It helps people have direct access to safe water and the overflow from the tank recharges the ground.
5. It provides the household with a large individual tank that can be used to store water for household use throughout the year.

The focus of this manual is staff working in NGO's and Voluntary organizations, technical persons, architects, engineers and any interested layman.

It explains the functioning and acts like a step-by-step guide for implementing an Individual Tank based Rainwater Harvesting system.

## What is Individual Tank based Rainwater Harvesting ?

The Individual Tank based Rainwater Harvesting system can be simply described as a system that harvests rainwater that falls on a house roof and stores it in a tank for day to day use. It is a simple way to have good quality, pure water at ones door step with very little effort.
The water that overflows from this tank can then be recharged into the ground through a recharge pit.

## The components of the standard Rainwater Harvesting System

An Individual Tank based Rainwater Harvesting system is made up of "Harvesting – Carrying – Filtering – Storage – Use"

### 1. Harvesting

We normally come across two types of harvesting structures, one is RCC slab Flat-roof and other is traditional sloping roof system. However for this manual we are considering flat roofs of roughly 35 square meters (350 Sq Feet) that have been typically built in the Tsunami reconstruction effort.

### 2. Carrying

In case of a flat-roof, a PVC pipe or Cement-pipe is appropriate and advisable.

### 3. Filtering

Rainwater is a pure form of water, free of any biological – bacterial contamination. However when it rains some suspended impurities in the atmosphere get dissolved in the rain. To prevent any form of contaminations of the water stored in the tank these impurities need to be filtered out.
This filtering is carried out in two stages

**A. First-Rain separator:**
The first rain-separator is a built-in plumbing- system that separates the first few minutes of the rain.

**B. Filter**
After the first rain separator, the rain water will still carry suspended impurities. These need to be filtered out. This can be done with a simple Sand - stone - charcoal filter. Even a clean folded cotton cloth placed in a sieve acts as an effective filter.

## 4. Water Storage Tank

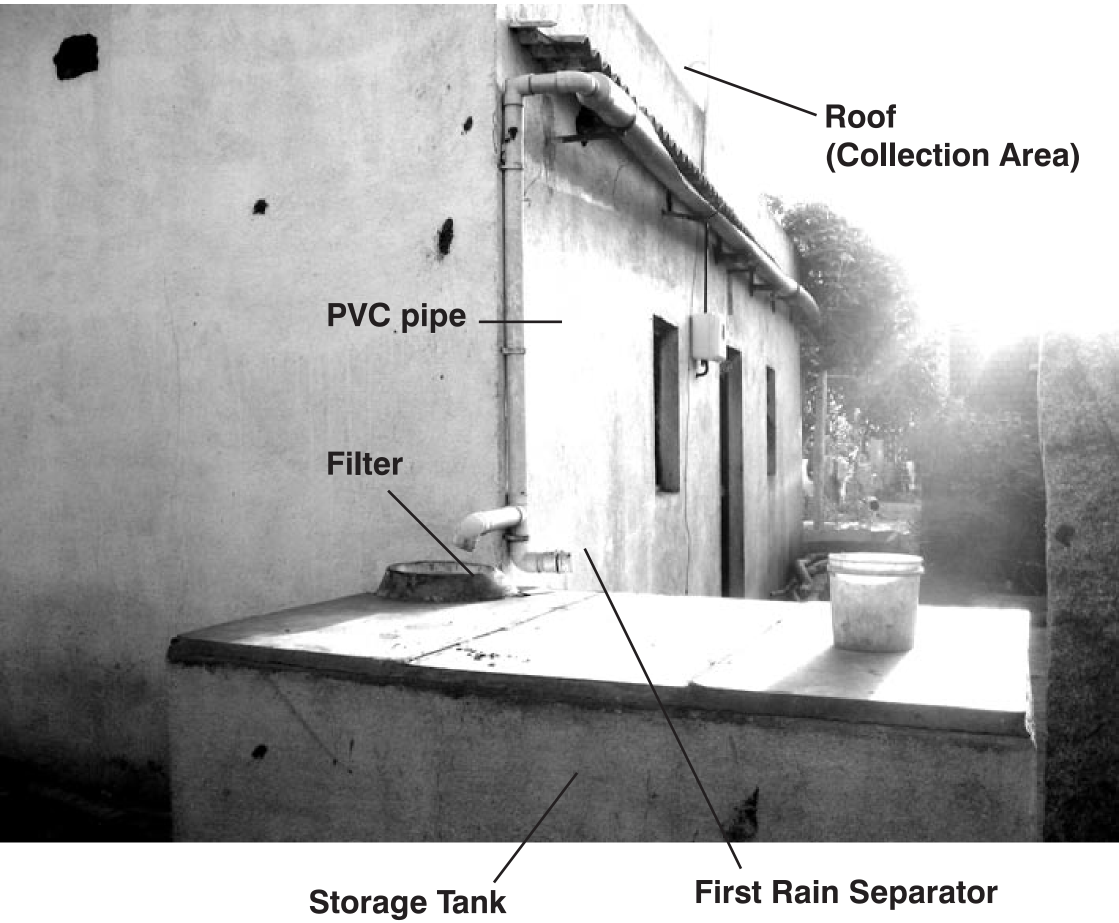
The last component which completes the Rainwater harvesting system is the water-tank. The water from filter is directed and stored in the Tank for day to day use.

Typically one can go for either of the following types of the tank.

i. A brick / stone masonry tank.
ii. Pre-cast Ferro-cement tanks.
iii. A Prolypropeylene tank (commonly known as Sintex)

## 5. Use

Water stored in the tank is fit for use. It can be used on a day to day basis for all needs except drinking and cooking. For the system to work well the user has to be interested in the system and do the little effort needed to keep it clean and functional.



# Step 1
# Harvesting House Roof

All house roofs whether flat or sloping play the role of the harvester. The quantity of water that can be harvested depends on the total area and on the roofing material.
The most important thing to keep in mind is that the roof should be cleaned of all leaves, dust or other material before the monsoons. The roof should be strictly free of any dangerous material like chemical / pesticides / fertilizers.

## House with Flat slab roof

A typical flat-slab house, constructed post-Tsunami is 350 sq ft built-up area. The roof of such a house would typically have one rainwater outlet. Replace existing water-outlet with 4” dia L-Junction, either PVC or Cement. The joint around is sealed with cement slurry. Check that the water does not stagnate in front of the water outlet. If so redo the surface so as to ensure flow of water.

L - junction

# Step 2
# Filtration

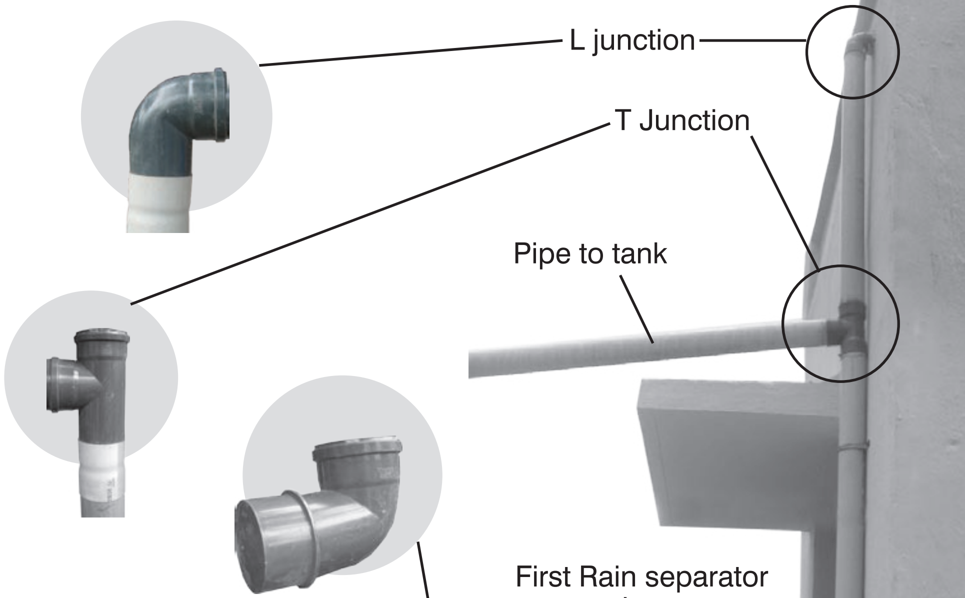
Rainwater is a pure form of water, free of any biological – bacterial contamination. However when it rains some suspended impurities in the atmosphere get dissolved in the rain. The roof and gutters have accumulated organic and inorganic matter in the form of leaves, dust, sand, mud etc. As the rain hits the roof all these impurities dissolve into the rainwater or are carried along. These impurities can affect the quality of the water collected. To prevent any form of contaminations of the water stored in the tank these impurities need to be filtered out.
This filtering is carried out in two stages

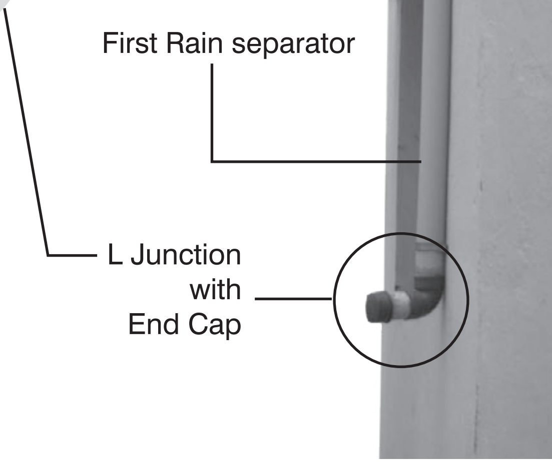
## 1. First Rain Separator

Most of the dust and organic matter deposited on the roof dissolves and flows within the first few minutes of the rain. This water needs to be separated in order to prevent contamination of water that is going to be stored in the tank.
The first rain-separator is a built-in plumbing-system that separates the first few minutes of the rain without any major need of supervision.

A 4” dia PVC T junction pipe is fixed onto the lower end of the L-junction that comes from the roof.

A 4” down-pipe is fixed to the lower end of the T-junction. It usually will go upto 30cm (1 feet) above the ground level.  The down-pipe is then provided with an L junction. This L junction has an end-cap.
This contraption from T-junction below works as First-rain separator.




**How it works:**
As the rainwater from roof flows down it first fills up the down pipe (described above as the first rain separator). The quantity of water stored in the downpipe equals the first few minutes of rain and will carry with it most impurities. As the downpipe fills up the water starts flowing out of the T junction (from its upper outlet) into the other downtake pipe which takes the water to the filter.
After every rain, it is advised that the end-cap from the bottom is released and water collected in this empty portion of pipe is flushed out. So that it is ready to store the first few minutes of the rain for next time.

*First Rain separator*

## 2. Downpipe

To the lower outlet of the T junction we have fixed the first rain separator described above. Fix a 4” L Junction to the other upper outlet. Fix a 4” downpipe to the L junction that goes to the filter described below.

## 3. Filter

The water that comes for filtration after the filling up of the first rain separator would still have suspended and dissolved impurities. These need to be filtered out. These filters can be of different types.

We can rely on a simple stone- sand-charcoal filter. It is easy to construct and maintain.

Take any container which has volume of about 20 Ltrs. A plastic drum (easily got from the market) of that capacity will work fine. A everyday plastic bucket can also be used. However since it is likely to collect a lot of dust and leaves it will have to be cleaned before the monsoon.. Make an opening in the drum cover so that a 4” dia PVC pipe can enter.

On one side of this drum/bucket (or on the bottom side) make an opening so that a 4” pipe can be fixed as an outlet. This joint should be sealed from the inside.

The container is filled with three layers , Baby jelly, charcoal, sand, starting from the bottom.

Baby-jelly is filled from bottom, then a layer of coarse-sand and on top a layer of charcoal.

At least 6” from top should be left open Slow percolation of water through the layers-filtration medium ensures that the dissolved and suspended impurities are filtered.


*Pipe being attached to drum filter*

**Note:** If more sophisticated filters are unavailable or are not possible due to cost constraints then a fine cotton cloth folded several times can also be used as filter. A combination of a cotton-cloth and aluminum mesh can serve as relatively effective filter.

*Aluminium mesh filter*

*Cloth filter*

For the filters to work properly they need to be cleaned on a regular basis.
All the material should be removed from the container and washed separately.
The container should be washed too. Then dry them in the sun for a day.
The filter material should be put back in the container.
The filter is now ready.

# Step 3
## Water-storage tank

The size/capacity of the water tank is a critical decision in the design of the Rainwater harvesting system. It is determined by various factors including

• Average Rainfall in the region and Rainfall pattern
• Roof-top area
• Water requirements of the family.
• Budget

In Rural-parts of Tamil Nadu, the cost-factor is likely to play the deciding role in determining tank size. For optimum utilization of the Rainwater harvesting system a water tank of 1500 – 2000 liter capacity is suitable.

Keeping in mind the needs of the local economy a masonry tank that employs a local mason is advisable The other equally important reason being that the tank top of a masonry tank can be used for various activities like drying food, seating, sleeping. The tank shape can also be according to our needs – for example a narrow space can have a vertical tank. This kind of flexibility is absent in Sintex type tanks. . It costs more or less the same as a Sintex type tank, but will ensure that the money instead of going to a material supplier goes to local masons and labour.

Masonry tank can be placed on the ground, partially below the ground or completely below ground-level. It should preferably be kept above ground. The reasons for this are the following.
Excavation of the ground for the tank that is partially or completely below ground costs money and will increase the cost of the system. Keeping it above the ground also allows for quick detection of leaks and their repair.

When building a ground level water tank
The place where the tank is going to be placed is leveled and the ground is well compacted.
Lay 4” thick, 1:4:8 bed concrete to make the bottom surface of the tank.
A single-brick wall is enough for a water tank thats upto 3 feet high.

To build tanks of height more than 3 feet the tank wall should be two brick thick.
The corners need to be strengthened.
The joints should be overlapped properly.
The internal surface is plastered with 1:3 cement-mortar. This plaster is then properly finished with a rich cement slurry. The external surface above ground is plastered with 1:6 cement-mortars.
During construction curing should be carried out regularly.
Once the tank is ready it needs to be filled with water and left for a week to test it for any leaks.
Provide 2” thick band of PCC 1:2:4 on top of the brick wall. The tank needs to be covered with a RCC slab, or Stone-slabs. Provide access or an option of someone going inside for cleaning purpose. Care needs to taken that no sunlight can reach the water in the tank.

A molded Polypropylene tank (popularly known as Sintex) can also be used. It should be placed on a raised even platform of 6 inch height PCC 1:4:8

*Concrete* Masonry *Tank*


Polypropylene tank

# Basic estimation of the expenses of a Rainwater Harvesting System

The following gives the basic costs of material needed to put a rain water harvesting system. With the help of this you can calculate the likely costs.

| Item | Total quantity | Unit rate (Rs) | Actual cost (Rs) |
|---|---|---|---|
| Water Tank | 1500 liters | 4 – 5 Rs/lit | 6,000 - 7,500 |
| 4” PVC pipe (quality medium) | 6m /20 feet | 60 Rs/meter | 360 |
| 4” T junction | 1 nos | 80 Rs | 80 |
| 4” L junction | 5 nos | 60 Rs | 300 |
| 4” End cap | 1 nos | 30 Rs | 30 |
| Collars | 6 nos | 30 Rs | 180 |
| Fixing bracket | 4 nos | 10 Rs | 40 |
| 20 litre drum / bucket | 1 nos | 200 Rs | 200 |
| PVC Glueing solvent | 1 nos | 30 Rs | 30 |
| Plumbing labour | 1 day | 250 Rs/day | 250 |
| Other material – charcoal, sand gravel | | | 200 |
| Incidental | | | 200 |
| **Total approximate cost** | | | 8,000 – 9,500 |

As is evident it is the cost of the water tank that is the major expense. Different ways to reduce this cost can be explored. 200 liter drums connected in series can serve water storage needs at a much lower cost.

# Potential of the Rainwater Harvesting System to provide water for daily household use

The following tables give the rain water harvesting potential of the Individual Tank based Rainwater harvesting system for each district in light of the rainfall patterns for each of the coastal districts of Tamil Nadu. The same calculations can be applied to any other region to have sure calculations of the potential of rainwater harvesting.

The rainfall data in the form of average annual and monthly rainfall on the basis of 10 years average (1992 – 2002) has been sourced from the following site http://www.indiawaterportal.org/mapguide/MetData/ajaxtiledviewersample.jsp

We assume

1. The roof-top collection area is 35 Sq Mt. (350 sq feet) – which is the average roof area of a house con structed post tsunami
2. Coefficient 0.8 corresponds to actual rainfall available for harvest ing after losses due to absorp tion by surface, filtration etc In other words 80% of the rain falling on a flat RCC roof can be harvested
3. Daily water need of the family at 150 liters (this does not include water for cooking and drinking)
4. A tank size of 1500 liters

# Rainwater Harvesting Potential

**Remember !**

Rainfall available for harvesting (litres) = (Total roof area x average rainfall) x 0.8 (Coefficient that takes into account loss of rainwater due to absorption and other losses)

For e.g. the district of Kanyakumari receives an average rainfall of 29 mm in the month of Jan. Therefore for a roof area of $35m^2$, the rainfall available for harvesting in the month of January = ($35m^2$ x 0.029m) x 0.8 = 0.812 $m^3$ = 812 litres

Potential of RWH system to provide water per month = Rainfall available for harvesting / Daily water requirement.

Assuming the daily water requirement of an average family to be around 150 liters, the potential of RWH system to provide water in Kanyakumari for the month of January = 812 / 150 = 5.4 days

## Kanyakumari

| Month | Average annual rainfall | Rainfall available for harvesting (litres) | Potential of RWH system to provide water (days/ month) |
|---|---|---|---|
| January | 29 mm | 812 lits | 5.4 days |
| February | 20 mm | 560 lits | 3.7 days |
| March | 48 mm | 1344 lits | 9 days |
| April | 111 mm | 3108 lits | 20.7 days |
| May | 158 mm | 4424 lits | 29.5 days |
| June | 211 mm | 5908 lits | 30 days |
| July | 150 mm | 4200 lits | 28 days |
| August | 87 mm | 2436 lits | 16.2 days |
| September | 102 mm | 2856 lits | 19 days |
| October | 246 mm | 6888 lits | 31 days |
| November | 206 mm | 5768 lits | 30 days |
| December | 70 mm | 1960 lits | 13 days |
| Total | 1438 mm | 40264 lits | 235.5 days |

**For the district of Kanyakumari rainfall alone can provide for the household water needs for roughly 8 months of the year**

## Tuticorin

| Month | Average annual rainfall | Rainfall available for harvesting (litres) | Potential of RWH system to provide water (days/ month) |
|---|---|---|---|
| January | 15 mm | 420 lits | 2.8 days |
| February | 50 mm | 1400 lits | 9.3 days |
| March | 11 mm | 308 lits | 2 days |
| April | 78 mm | 2184 lits | 14.5 days |
| May | 69 mm | 1932 lits | 12.9 days |
| June | 77 mm | 2156 lits | 14.4 days |
| July | 37 mm | 1036 lits | 6.9 days |
| August | 28 mm | 784 lits | 5.2 days |
| September | 50 mm | 1400 lits | 9.3 days |
| October | 222 mm | 6216 lits | 31 days |
| November | 212 mm | 5936 lits | 30 days |
| December | 88 mm | 2464 lits | 16 days |
| Total | 937 mm | 26236 lits | 154.3 days |

**For the district of Tuticorin rainfall alone can provide for the household water needs for slightly over 5 months of the year**

## Ramanathapuram

| Month | Average annual rainfall | Rainfall available for harvesting (litres) | Potential of RWH system to provide water (days/ month) |
|---|---|---|---|
| January | 31 mm | 868 lits | 5.8 days |
| February | 51 mm | 1428 lits | 9.5 days |
| March | 9 mm | 252 lits | 1.7 days |
| April | 116 mm | 3248 lits | 21.6 days |
| May | 86 mm | 2408 lits | 16 days |
| June | 120 mm | 3360 lits | 22.4 days |
| July | 60 mm | 1680 lits | 11.2 days |
| August | 77 mm | 2156 lits | 14.4 days |
| September | 95 mm | 2660 lits | 17.7 days |
| October | 277 mm | 7756 lits | 30 days |
| November | 283 mm | 7924 lits | 31 days |
| December | 130 mm | 3640 lits | 24.2 days |
| Total | 1335 mm | 41020 lits | 205.5 days |

**For the district of Ramanathapuram rainfall alone can provide for the household water needs for almost 7 months of the year**

## Pudukottai

| Month | Average annual rainfall | Rainfall available for harvesting (litres) | Potential of RWH system to provide water (days/ month) |
|---|---|---|---|
| January | 25 mm | 700 lits | 4.6 days |
| February | 38 mm | 1064 lits | 7 days |
| March | 5 mm | 140 lits | 1 day |
| April | 57 mm | 1596 lits | 10.6 days |
| May | 27 mm | 756 lits | 5 days |
| June | 13 mm | 364 lits | 2.4 days |
| July | 16 mm | 448 lits | 3 days |
| August | 21 mm | 588 lits | 4 days |
| September | 28 mm | 784 lits | 5.2 days |
| October | 198 mm | 5544 lits | 31 days |
| November | 268 mm | 7504 lits | 30 days |
| December | 150 mm | 4200 lits | 28 days |
| Total | 846 mm | 23688 lits | 131.8 days |

**For the district of Pudukottai rainfall alone can provide for the household water needs for roughly 4.5 months of the year**

## Thanjavur

| Month | Average annual rainfall | Rainfall available for harvesting (litres) | Potential of RWH system to provide water (days/ month) |
|---|---|---|---|
| January | 19 mm | 532 lits | 3.5 days |
| February | 19 mm | 532 lits | 3.5 days |
| March | 4 mm | 112 lits | 0.7 days |
| April | 42 mm | 1176 lits | 7.8 days |
| May | 32 mm | 896 lits | 6 days |
| June | 32 mm | 896 lits | 6 days |
| July | 31 mm | 868 lits | 6 days |
| August | 55 mm | 1540 lits | 10.3 days |
| September | 63 mm | 1764 lits | 11.7 days |
| October | 202 mm | 5656 lits | 31 days |
| November | 228 mm | 6384 lits | 30 days |
| December | 144 mm | 4032 lits | 27 days |
| Total | 871 mm | 24388 lits | 143.5 days |

**For the district of Thanjavur rainfall alone can provide for the household water needs for almost 5 months of the year**

## Nagapattinam & Karaickal

| Month | Average annual rainfall | Rainfall available for harvesting (litres) | Potential of RWH system to provide water (days/ month) |
|---|---|---|---|
| January | 24 mm | 672 lits | 4.5 days |
| February | 14 mm | 392 lits | 2.6 days |
| March | 3 mm | 0 lits | 0 days |
| April | 28 mm | 783 lits | 5.2 days |
| May | 36 mm | 672 lits | 4.5 days |
| June | 43 mm | 1204 lits | 8 days |
| July | 38 mm | 1064 lits | 7 days |
| August | 74 mm | 2072 lits | 13.8 days |
| September | 75 mm | 2072 lits | 13.8 days |
| October | 200 mm | 5600 lits | 31 days |
| November | 276 mm | 7728 lits | 30 days |
| December | 200 mm | 5600 lits | 31 days |
| Total | 1011 mm | 22819 lits | 137.6 days |

**For the district of Nagapattinam & Karaickal rainfall alone can provide for the household water needs for about 4.5 months of the year**

## Pondicherry & Cuddalore

| Month | Average annual rainfall | Rainfall available for harvesting (litres) | Potential of RWH system to provide water (days/ month) |
|---|---|---|---|
| January | 20 mm | 560 lits | 3.7 days |
| February | 12 mm | 336 lits | 2 days |
| March | 4 mm | 112 lits | 0.7 days |
| April | 17 mm | 476 lits | 3.1 days |
| May | 49 mm | 1372 lits | 9 days |
| June | 48 mm | 1372 lits | 9 days |
| July | 48 mm | 1372 lits | 9 days |
| August | 108 mm | 3072 lits | 20.5 days |
| September | 107 mm | 3072 lits | 20.5 days |
| October | 226 mm | 6328 lits | 31 days |
| November | 271 mm | 7588 lits | 30 days |
| December | 174 mm | 4872 lits | 31 days |
| Total | 1284 mm | 30532 lits | 169.5 days |

**For the district of Pondicherry & Cuddalore rainfall alone can provide for the household water needs for roughly 6 months of the year**

## Kanchipuram

| Month | Average annual rainfall | Rainfall available for harvesting (litres) | Potential of RWH system to provide water (days/ month) |
|---|---|---|---|
| January | 17 mm | 476 lits | 3 days |
| February | 16 mm | 448 lits | 3 days |
| March | 1 mm | 0 lits | 0 days |
| April | 8 mm | 224 lits | 1.5 days |
| May | 44 mm | 1234 lits | 8.2 days |
| June | 49 mm | 1372 lits | 9 days |
| July | 67 mm | 1876 lits | 12.5 days |
| August | 150 mm | 4200 lits | 28 days |
| September | 117 mm | 3276 lits | 21.8 days |
| October | 250 mm | 7000 lits | 31 days |
| November | 336 mm | 9408 lits | 30 days |
| December | 198 mm | 5544 lits | 31 days |
| Total | 1153 mm | 35058 lits | 179 days |

**For the district of Kanchipuram rainfall alone can provide for the household water needs for roughly 60 months of the year**

# Important questions on Individual Tank based Rainwater Harvesting systems

## 1. The water we collect from rain, is it safe?

Rainwater is a pure form of water, free of any biological – bacterial contamination. However when it rains some suspended impurities in the atmosphere get dissolved in the rain. The roof and gutters have accumulated organic and inorganic matter in the form of leaves, dust, sand, mud etc. As the rain hits the roof most of these impurities dissolve into the rainwater or are carried along.
A simple filtration process, use of the sand-stone-charcoal filter, or even a cotton cloth and mesh filter will help us filter most the dissolved and other impurities.
Care has to be taken to keep the roof and gutters clean. This will reduce the number of impurities in the first place.
The storage tank should be kept clean and properly covered at all times. This is important in keeping the water clean.

## 2. Can we use rainwater for all the daily consumption?

The water collected from rain is like any other water so it can be used for all the activities. We should refrain from using this water for cooking and drinking unless otherwise boiled and filtered.

## 3. Will the Individual Tank Rainwater Harvesting system provide for water needs through out the year?

No, the number of days that this system will serve an individual household depends on various factors like rainfall pattern, the storage capacity of the tank, and the area of roof, household needs etc. However as shown in tables above it could provide safe water in sufficient quantities for a period of 4.5 to 8 months of the year.

## 4. How much does it cost to build the RWH system?

We have provided the sample break-up of items for the estimate of the RWH system at domestic level. Water-Tank is the most expensive ‘factor’ in the construction of RWH. The estimate will vary depending on the cost of the water-tank.

To give a rough estimate, a system with a tank of capacity 1500 liters will cost you roughly 8,000 rupees.

## 5. What all maintenance does this RWH system demands?

1. Check if the gutter system once every year. Clean it of any debris, sand that has accumulated in it. In case you notice that there is a blockage then a bucket of water thrown with some force down the pipes could help clear it
2. Filter should be cleaned once in a year. Remove the filtration medium from the filter, wash the medium thoroughly, put all the material in direct-sunlight for few days, and refill the filter.
   It is advisable that the water-tank is cleaned twice every year.
3. The roof should be cleaned on a regular basis especially before the monsoon

Notes

## Credits

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ARCHITECTURE & DEVELOPMENT (A&D) India, is the counterpart of Architecture & Developpement, an NGO founded in 1997 in Paris. A&D was registered as a Trust in India based in Visakhapatnam, Andhra Pradesh in South India.

A&D works in partnership with many NGOs interested in issues related to Sustainable Habitats in various parts of the world. Involved in activities ranging from reconstruction programs in tsunami affected areas, networking among NGOs, professionals and academia, information dissemination, initiating and implementing exchange programs for professionals and development activists etc. A&D's main objective is to reinforce the competences of professionals so that it will support in affirming their role and responsibility as citizens in society and a pooling of resources, competences and expertise in various fields.


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